Topological Aspects of the Spin Hall Effect(Topological Aspects of Solid State Physics)

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DAY 4: 10:50 – 11:30

Topological Aspects of the Spin Hall Effect

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The spin Hall effect is a generalization of the usual (charge) Hall effect, when spin degrees of freedom of the constituent particles of the condensed matter system as well as the spin dependent interactions are taken into account. In this talk I will review several works of collaborators and me on topological aspects of the spin Hall effect. Since the spin Hall effect happens in the absence of a magnetic field, so time-reversal symmetry is not broken. This will bring a few new features to the topological considerations in the theory of the spin Hall effect.

DAY 4: 11:30 – 12:10

Novel properties of bismuth in high magnetic fields

Jason Alicea
Caltech

In sharp contrast to most three-dimensional metals, the carrier density in bulk bismuth is sufficiently low that lowest-Landau-level physics can be explored with laboratory fields. Very recent experiments probing this high-field regime have uncovered a number of surprising features which raise interesting new questions for this material. Specifically, observations of anomalies in the Hall resistance, Nerst effect, and magnetization measurements have led to the speculation that three-dimensional bismuth in the quantum limit may host correlated states, and possibly even electron fractionalization. In this talk I will discuss a recent analysis of an interacting low-energy theory for bismuth in a magnetic field, describing Dirac-like electrons coupled to holes, which allows one to begin shedding light on these phenomena. I will argue that an anomalous Zeeman effect that arises due to strong spin-orbit coupling, together with an instability to charge-density-wave order in the highest fields may account for some of the puzzling observations. Outstanding questions and interesting future experimental directions will also be discussed.